FISKERIDIREKTORATETS SKRIFTER
Serie Havundersøkelser
(Report on Norwegian Fishery and Marine Investigations)
Vol XII. No. 8

Investigations on Pelagic Fry of Cod and Haddock in Coastal and Offshore Areas of Northern Norway in July—August 1957

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1960
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INTRODUCTION

In the period 9. July—31. August 1957 investigations of small and fat herring were carried out from the R/V "G. O. Sars" in coastal and offshore areas of northern Norway. During the cruise a number of horizontal hauls were taken with a Petersen pelagic youngfish trawl. As a rule, the trawl was towed for 15 minutes in steps with 150, 125 and 100 m wire respectively at a speed of two knots, the corresponding depths being estimated to 45 m, 23 m and 12.5 m respectively. Hydrographical observations and vertical Nansen ("8/72") net hauls 100—0 m were taken on 234 stations.

A preliminary report of the cruise has been published by DRAGESUND and LJØEN (1957), and I take this opportunity to express my gratitude to Mr. DRAGESUND for entrusting me with the material of fish fry and zooplankton.

Kr. Fr. Wiborg.

HORIZONTAL DISTRIBUTION OF THE COD AND HADDOCK

The cod and haddock fry was chiefly taken in the area from the Vestfjord and northwards (Fig. 1). Farther south the hauls were mainly negative. The sts. 505—599 were worked from 17. to 31. July, sts. 606—707, 4. to 18. August, and sts. 720—734, 21. to 31. August. The haddock was most abundant, especially from Sørøy and northwards, maximum 69 fry

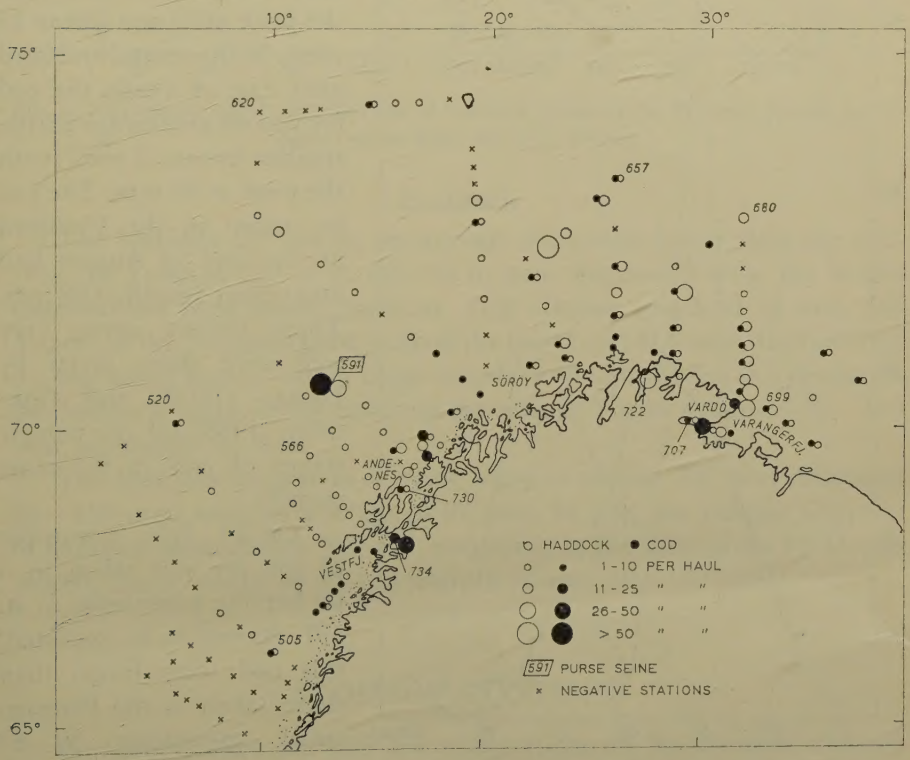

Fig. 1. The quantitative distribution of cod and haddock of the O-group taken in 20 minutes hauls with the Petersen youngfish trawl (200—50 m wire) July 17—August 31. 1957. Oblique figures, station numbers.

per horizontal haul, at a number of stations 15—40 fry per haul. The cod fry was mainly distributed along the coast from Andenes to Sørøy as a rule less than 10 individuals per haul, sometimes as much as 35. At the end of August, 30 fry were taken per haul in the inner part of the Vestfjord.

LENGTH FREQUENCIES OF THE COD AND HADDOCK

The fish fry was measured in millimetres, and the figures combined in groups of 5 mm.

Cod

During the first part of the cruise (sts. 505—699) the cod sampled on the whole had the same length distribution, and all the figures have been combined into one curve (Fig. 2). The lengths vary from 30 to 80 mm, with the peak at 55 mm (mean 54 mm). In the coastal and fjord area east of Vardø the cod fry was on an average a little smaller (mean 53 mm), with the peak at 45 mm. The cod fry taken in the Vestfjord at the end of August had an average length of 68 mm. These figures agree very well with those given by Damas (1909) and Corlett (1958) for the pelagic stages of cod in the same months.

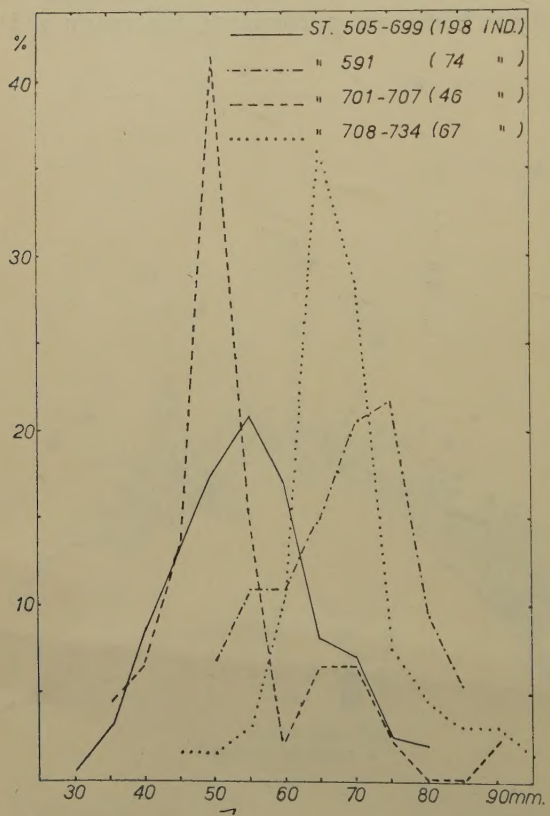

Fig. 2. Percentage length distributions of cod taken in the Petersen pelagic trawl, and in purse seine (st. 591), in mm.

On 21. July, a number of cod fry was taken in a fat herring purse seine at st. 591. As was to be expected, this cod were larger than those taken in the Petersen trawl, measuring 50—85 mm, mean length 69 mm. (Fig. 2).

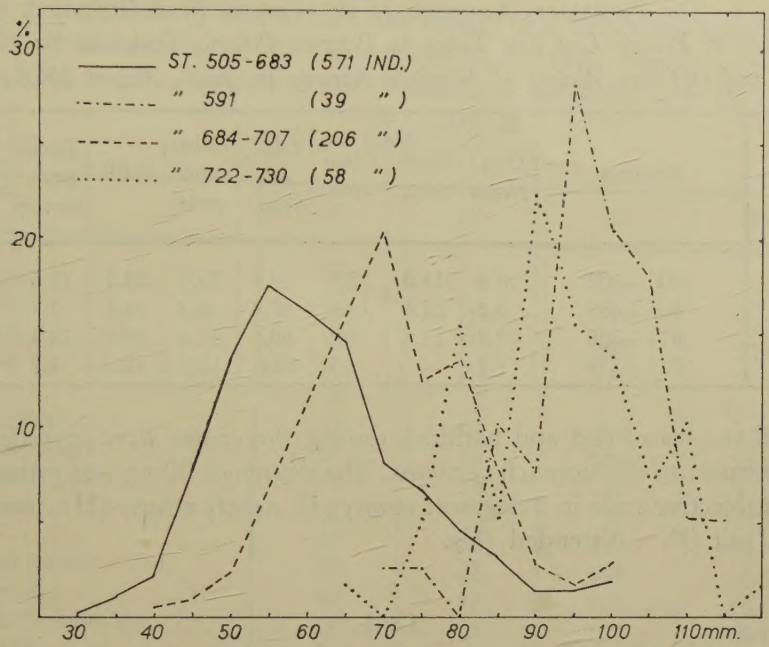

Fig. 3. Percentage length distributions of haddock taken in the Petersen pelagic trawl, and in purse seine (st. 591), in mm.

Haddock

The haddock fry was on an average somewhat larger than the cod. (Fig. 3). From st. 505 to st. 683, 90 n. miles north of Vardø, the length distributions were mostly uniform, with a mean length of 62 mm. Off Vardø, in the Varangerfjord, and on the banks east of Vardø, the haddock fry was much larger, with a mean length of 73 mm. At the end of August the haddock taken in the fjords to the west of Vardø measured 80—110 mm, averagely 92 mm.

The haddock caught in a purse seine at station 591 also measured 80—110 mm, with an average of 97 mm. In July the pelagic O-group of haddock off northern Norway, according to the data given by Damas (1909), has a length of 50—90 mm, in August 60—110 mm.

STOMACH CONTENTS

Previously, there are very few observations on the stomach contents of pelagic cod and haddock of the length group 30—100 mm. The author has studied the stomach contents of demersal and littoral cod of the O-group in the waters of northern Norway (Wiborg 1948, 1949).

Table 1. *The Percentage Occurrence of the Various Food Organisms in the Stomachs of Pelagic Cod Fry Taken in Petersen Pelagic Trawl in the Coastal and Offshore Waters of Northern Norway in July—August 1957.*

Area	Stations	*Oiko-pleura*	*Fritil-laria*	*Lima-cina*	*Cala-nus finm.*	Other cope-pods	Krill	Deca-pod-larvae	Lar-vae of bottom inv.
I	505—602	18.5	14.8	2.5	*44.4*	29.6	28.4	13.6	22.2
II	604—669	5.4	21.4	14.3	*57.4*	*46.4*	14.3	7.1	1.8
III	671—708	3.2	11.6	7.4	*60.0*	27.4	*48.4*	12.6	33.7
IV	727—734	1.7	—	8.5	22.0	15.3	*47.5*	1.7	3.4

All the fry of cod and haddock during the cruise were investigated with respect to the stomach contents. The degree of filling was estimated on a subjective scale in 5 degrees: empty (I), nearly empty (II), medium (III), full (IV), distended (V).

Cod

A total of 371 stomachs of cod fry from 63 stations has been investigated. Except for 72 cod taken in the purse seine, all of which had the stomachs distended (V), the filling indexes of the other stomachs were distributed as follows:

Degree of filling	I	II	III	IV	V
Per cent of the stomachs	8	10	32	37	14

Most of the stomachs had a filling index of III—IV.

The stomach contents were dissected out and investigated under a low powered stereoscopic microscope. The organisms found in the stomachs were grouped as shown in Table 1, and the percentage occurrence of the different groups calculated for four separate areas.

The copepods range first as food organisms, mainly *Calanus finmarchicus*, next come *Oithona similis* and neritic copepods. The second important group is the krill or euphausiids, the third one the copelates, *Fritillaria borealis* and *Oikopleura* spp. Local occurrences of *Balanus*-nauplii and larvae of pagurids at the sts. 598, 599, 690, 704 and 707, which are all located near the coast, explain the comparatively high percentage of bottom invertebrate larvae and decapod larvae in the areas I and III. *Limacina retroversa* is of a certain importance as food in the area north of Sørøy.

As mentioned previously, the cod taken in a purse seine north of Andenes were larger than those from the trawl catches, and the stomach contents were also different.

Table 2. *A, Number of Stations with Cod Feeding on a Particular Organism, B, Number of Cod Feeding on this Organism at A, C, Total Number of Cod investigated at A, D, Frequency of the Organisms in the Stomachs of the Cod at A in per Cent* $\frac{100 \cdot B}{C}$.

	A	B	C	D
Medusae	1	1	35	2.9
Oikopleura	*16*	33	113	29.9
Fritillaria sp.	*18*	25	100	25.0
Limacina	13	24	111	21.6
Clione	1	2	9	(22.2)
Calanus finm.	*44*	*148*	335	*44.0*
Other copepods	*37*	87	250	34.8
Cladocerans	10	14	31	*45.2*
Ostracods	2	5	34	14.7
Krill	*32*	*108*	234	*46.1*
Decapod larvae	*19*	32	163	19.5
Amphipods	10	17	103	16.5
Larvae of bottom inv.	*19*	*53*	135	*39.3*
Herring fry	5	7	52	13.4
Fishes, indet.	8	16	138	11.6
Chaetognaths	1	1	2	(50.0)
Insects	2	2	31	6.5

In the 72 stomachs investigated, the percentage frequency of the various food organisms was as follows:

	Limacina retroversa	*Calanus finmarchicus*	Krill	Herring fry	Redfish fry	Fish fry indet.
% of all stomachs	12	4	49	49	71	3

The larger food organisms, such as krill, and fry of herring and redfish are of greatest importance. The maximum size of the herring was 35 mm, of the redfish 13 mm.

If we only consider those stations where a particular food organism is found in the stomachs of one or more cod, the frequency may indicate if the cod prefers a certain kind of food, supposing that the organism has been present in the plankton in sufficient numbers. (Table 2).

As in Table 1, the organisms dominating are *Calanus finmarchicus* and other copepods, krill, bottom invertebrate larvae and appendicularians, but other groups may be of local importance, such as *Limacina*, cladocerans, amphipods and fish fry.

Table 3. *The Percentage Occurrence of the Various Food Organisms in the Stomachs of Pelagic Haddock Fry Taken in Petersen Pelagic Trawl in the Coastal and Offshore Waters of Northern Norway in July—August 1957.*

Stations	Medusae	*Oikopleura*	*Fritillaria*	*Limacina*	*Clione*	*Cal. finm.*	Other cop.	Krill	Decapodl.	Larvae of bottom inv.
505—602 ..	27.8	33.3	13.5	13.5	11.9	28.6	13.5	21.4	6.3	10.3
608—669 ..	21.1	21.7	41.1	42.5	3.6	57.5	37.7	16.9	2.1	6.9
671—708 ..	11.1	22.2	39.4	21.1	1.8	63.8	17.6	32.3	5.7	14.7
727—734 ..	73.7	21.1	—	10.5	—	15.8	10.5	—	21.1	10.5

The number of organisms per stomach vary considerably according to the relative size of the food organism and the fish, a maximum number of 15 krill or 40—50 adult *Calanus* being found.

Haddock

In all, 829 stomachs of haddock from 89 stations have been investigated. The filling index has been determined in the same way as in the cod, with the following result:

Degree of filling	I	II	III	IV	V
Per cent of the stomachs	4	6	26	50	14

The haddock had on the whole a little more stomach content than the cod.

The occurrence of the food organisms in the stomachs of the haddock has been tabulated in the same way as for the cod (Table 3).

The diet of the haddock is somewhat different from that of the cod, although both fishes have been caught in the same water mass. *Calanus finmarchicus* is still the most important food animal, but the medusae have been added as a new, important group, which in August completely dominates in the stomach contents of haddock taken in the fjords, while the krill is then entirely lacking. Appendicularians, *Limacina* and *Clione* are all of much greater importance than in the cod, whereas the krill has an average percentage frequency of 17, as compared with 35 in the cod. The difference in diet may to a certain extent be explained, as the haddock is mainly found in the northernmost areas and far out in the sea, the cod more close to the coast. But if we compare the diet of the two fishes at the same stations, the same difference is again found.

In Table 4 the occurrence of the food animals in the stomach contents of haddock has been tabulated in the same way as for the cod (Table 2).

Table 4. *A, Number of Stations with Haddock Feeding on a Particular Organism, B, Number of Haddock Feeding on this Organism at A, C, Total Number of Haddock Investigated at A, D, Frequency of the Organisms in the Stomachs of the Haddock at A in per Cent:* $\frac{100 \cdot B}{C}$

	A	B	C	D
Medusae	46	162	620	26.1
Oikopleura sp.	49	199	557	35.7
Fritillaria sp.	40	285	584	*48.8*
Limacina	33	220	455	*48.4*
Clione	22	333	322	14.9
Calanus finm.	62	409	686	*59.6*
Other copepods	39	194	514	*37.7*
Cladocerans	6	13	62	21.0
Ostracods	7	17	67	25.4
Krill	54	178	635	28.0
Decapod larvae	22	53	365	14.5
Amphipods	33	62	392	15.8
Larvae of bottom inv.	34	81	458	17.7
Herring fry	13	16	130	12.3
Redfish fry	4	4	139	2.9
Fish indet.	16	18	158	11.4
Tomopteris sp.	3	2	13	15.4
Chaetognaths	7	9	87	10.3
Insects	5	8	60	13.3

It is again stated that medusae, appendicularians, *Limacina* and *Clione* are more important as food for the haddock than for the cod, whereas krill and larvae of bottom invertebrates are of less importance.

The other food animals have approximately the same frequency in the haddock stomachs as in those of the cod.

A total of 41 small haddock was caught with a purse seine at st. 591. They were larger than the cod taken at the same time (see Fig. 3). All the haddock had food in their stomachs, as shown below:

	Limacina	Krill	Crustacean larvae	Herring fry	Redfish fry	Fish fry indet.
Frequency, %	80	20	7	7	49	2

The same food animals were found in the cod stomachs, but in the haddock the frequency is different. *Limacina* is of greatest importance,

whereas krill and especially herring fry, are of little importance. Redfish fry is relatively numerous, but not so important as in the cod (71%).

As adults, the cod and haddock differ in their food habits, the haddock in some periods feeding more intensely on bottom animals. But there is evidently a difference even in the pelagic stage, at an age of 3—4 months or perhaps less.

In Table 5 is shown the occurrence of various food organisms in the stomachs of cod and haddock at the different stations. The plankton organisms taken in Nansen net hauls at the same stations are also indicated. As the different species are very often found in separate lumps in the stomach, the cod and haddock evidently select the most suitable food organisms. But the food animals have also been shown to occur in definite swarms in the plankton. For the same reason the animals may be present in the stomachs, but lacking in the plankton sample from the same station. It is, however, to be taken into consideration, that the fish fry has been caught in horizontal hauls, and may also have migrated while in search for food, whereas the plankton has been sampled in vertical hauls.

SUMMARY

In July -August 1957 the distribution of pelagic cod and haddock of the O-group was investigated in the coastal and offshore waters of northern Norway. The cod was most abundant near the coast, the haddock also numerous farther offshore, and usually outnumbered the cod.

The cod measured 30—90 mm, the average lengths increasing from 53—55 mm in July to 65 mm in August. Cod, taken in a purse seine off Andenes in July, measured 50—85 mm.

The haddock measured 30—110 mm, the average lengths increasing during the cruise from 62 mm to 92 mm. Purse seined haddock measured 80—110 mm.

Copepods were most important as food both for cod and haddock, *Calanus finmarchicus* ranging first. The other food components were of varying significance in the two fishes. The cod had eaten krill and appendicularians to a great extent, locally also *Limacina*, cladocerans, amphipods and fish fry. The larger cod taken in the purse seine, had mainly taken fry of redfish and herring, and krill.

In the haddock, appendicularians, *Limacina* and *Clione* were generally of greater importance than in the cod, whereas krill had been eaten to a much smaller extent. Locally, medusae played a great part in the diet.

Limacina was found in 80 per cent of the stomachs of the haddock taken in purse seine, while krill and herring fry were met with in only 20 and 7 per cent respectively.

A comparison of the food organisms with those taken in simultaneous plankton hauls indicates that the fish to a certain extent select their food, partly that the food organisms may occur in swarms in the plankton.

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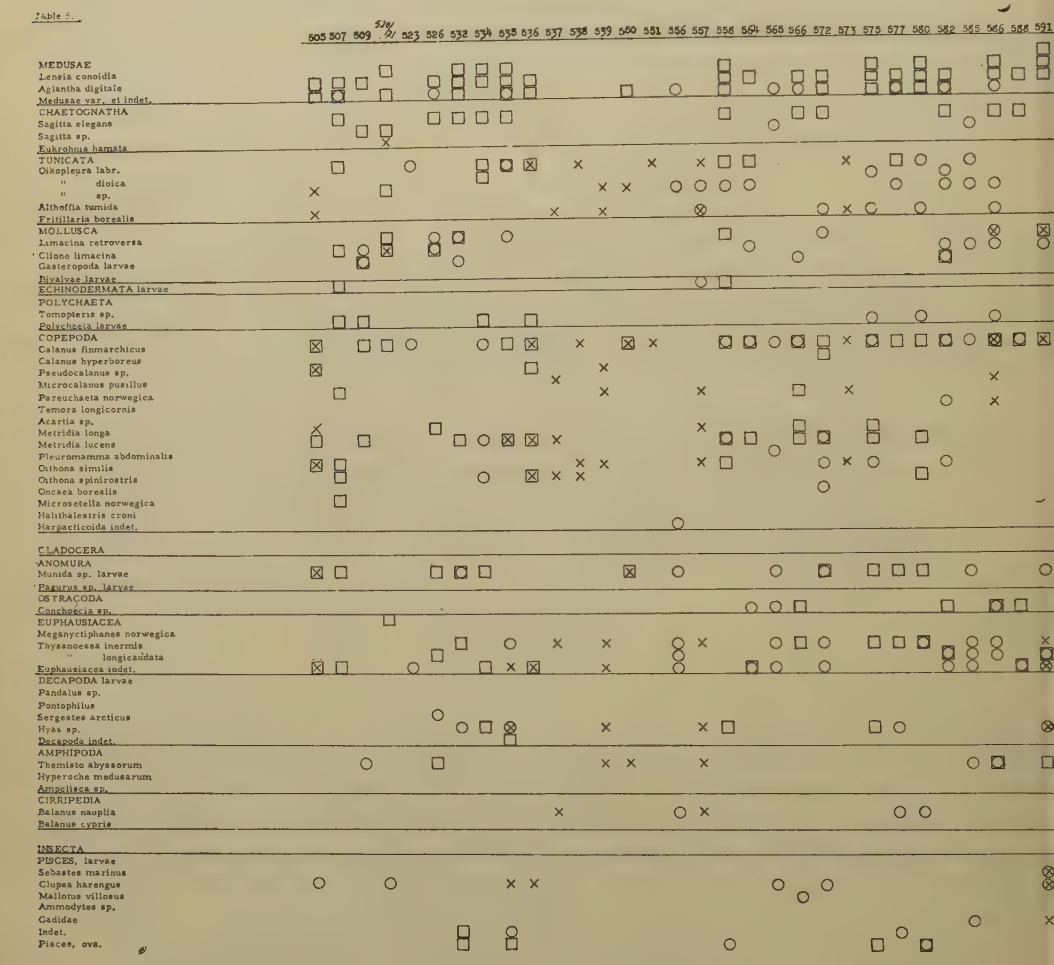
Wiborg, K. F. 1948. Some observations on the food of cod (*Gadus callarias* L.) from deep water and the littoral zone in northern Norway and from deep water at Spitzbergen. *Fiskeridir. Skr. Ser. Havundersøk.* 9 (4). pp 1—19.

— 1949. The food of cod (*Gadus callarias* L.) of the O—II group from deep water in some fjords of northern Norway. *Ibid.* 9 (8). pp 1—25.

Table 5. *Plankton Organisms Found in Stomachs of Cod* ×, *of Haddock* ○, *and in Vertical Nansen Net Hauls* □, *off Northern Norway in July—August 1957.*



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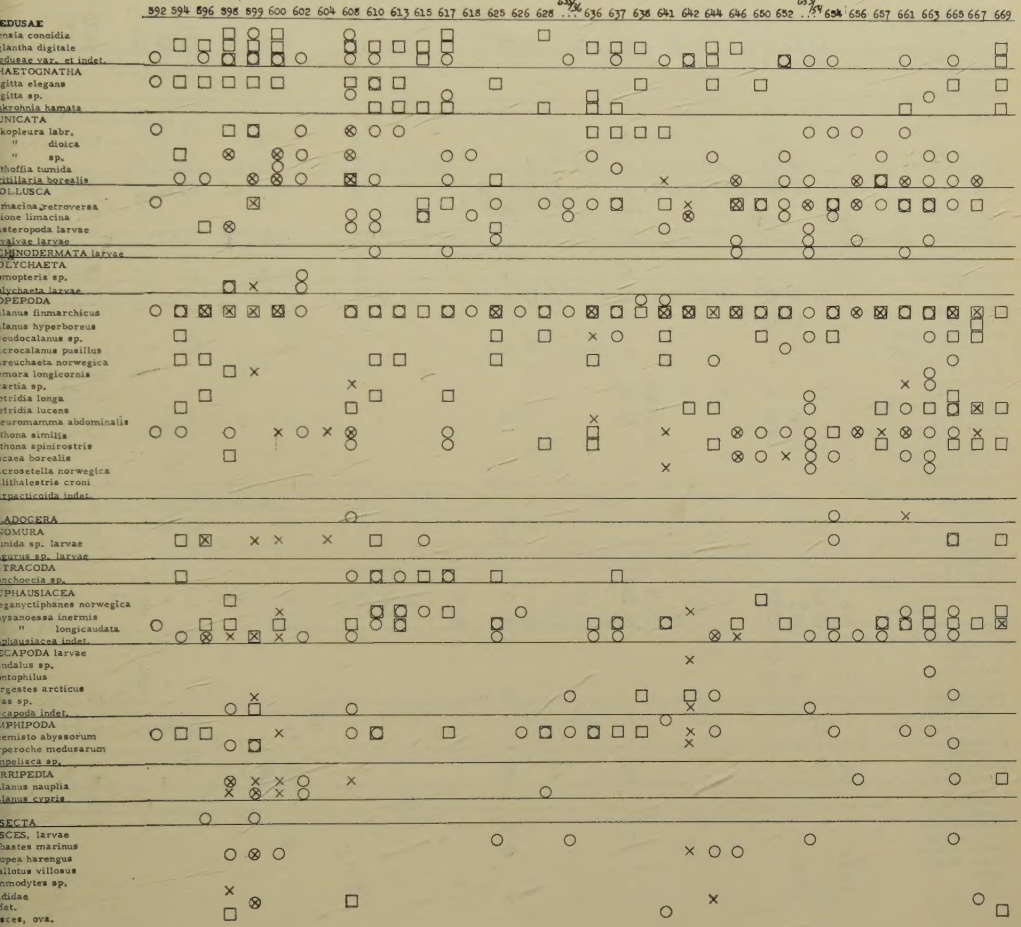

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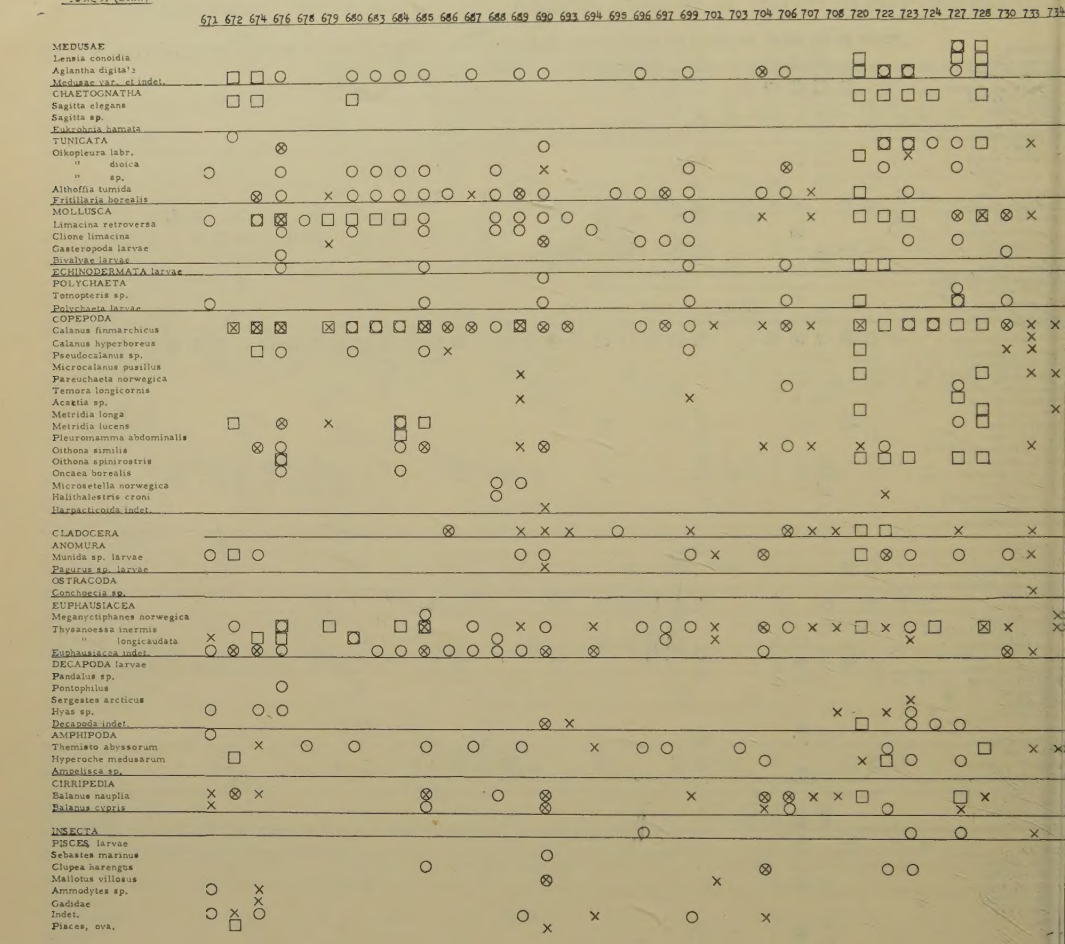
Table 5. (Cont.)
671 672 674 676 678 679 680 683 684 685 686 687 688 689 690 693 694 695 696 697 699 701 703 704 706 707 708 720 722 723 724 727 728 730 733 734
MEDUSAE
Lensia conoidia
Aglantha digita¹₂
Medusae var. et indet.
CHAETOGNATHA
Sagitta elegans
Sagitta sp.
Eukrohnia hamata
TUNICATA
Oikopleura labr.
" dioica
" sp.
Althoffia tumida
Fritillaria borealis
MOLLUSCA
Limacina retroversa
Clione limacina
Gasteropoda larvae
Bivalvae larvae
ECHINODERMATA larvae
POLYCHAETA
Tomopteris sp.
Polychaeta larvae
COPEPODA
Calanus finmarchicus
Calanus hyperboreus
Pseudocalanus sp.
Microcalanus pusillus
Pareuchaeta norwegica
Temora longicornis
Acartia sp.
Metridia longa
Metridia lucens
Pleuromamma abdominalis
Oithona similis
Oithona spinirostris
Oncaea borealis
Microsetella norwegica
Halithalestris croni
Harpacticoida indet.
CLADOCERA
ANOMURA
Munida sp. larvae
Pagurus sp. larvae
OSTRACODA
Conchoecia sp.
EUPHAUSIACEA
Meganyctiphanes norwegica
Thysanoessa inermis
" longicaudata
Euphausiacea indet.
DECAPODA larvae
Pandalus sp.
Pontophilus
Sergestes arcticus
Hyas sp.
Decapoda indet.
AMPHIPODA
Themisto abyssorum
Hyperoche medusarum
Ampelisca sp.
CIRRIPEDIA
Balanus nauplia
Balanus cypris
INSECTA
PISCES larvae
Sebastes marinus
Clupea harengus
Mallotus villosus
Ammodytes sp.
Gadidae
Indet.
Pisces, ova.